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Hoffmann et al.

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(54) **AD-HOC RADIO COMMUNICATIONS SYSTEM**

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H04L 29/06	(2006.01)
H04W 12/02	(2009.01)
H04W 84/18	(2009.01)

(52) **U.S. Cl.**

CPC ***H04L 63/0471*** (2013.01); ***H04W 12/02*** (2013.01); *H04W 84/18* (2013.01)

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CPC H04W 12/00; H04W 12/04; H04W 84/12; H04W 12/02; H04W 84/18; H04L 63/061; H04L 63/0428; H04L 63/00; H04L 63/04; H04L 63/0471

USPC 370/338, 328, 323, 352; 709/206; 375/148; 713/182

See application file for complete search history.

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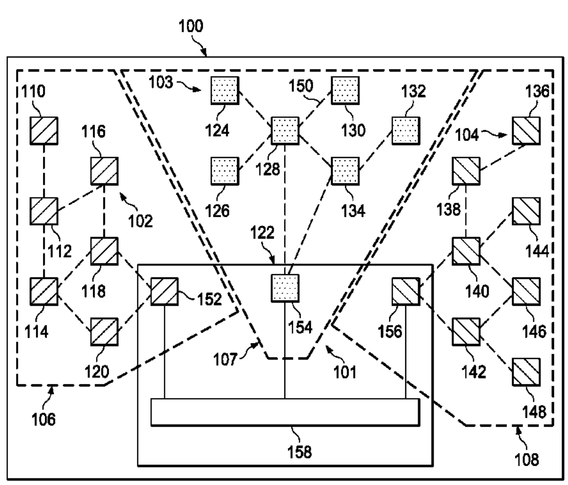
(57) **ABSTRACT**

A wireless communications system comprising a wireless communications unit. The wireless communications unit comprises a communications device, a back-end router, a cryptographic module connected to the back-end router, and a front-end router connected to the cryptographic module and the communications device. The communications device is configured to exchange information over a single wireless communications channel. The front-end router is configured to perform at least one of sending a first data packet received at the front-end router from the communications device to the back-end router through the cryptographic module and sending a second data packet received at the front-end router from the back-end router through the cryptographic module to the communications device.

11 Claims, 7 Drawing Sheets



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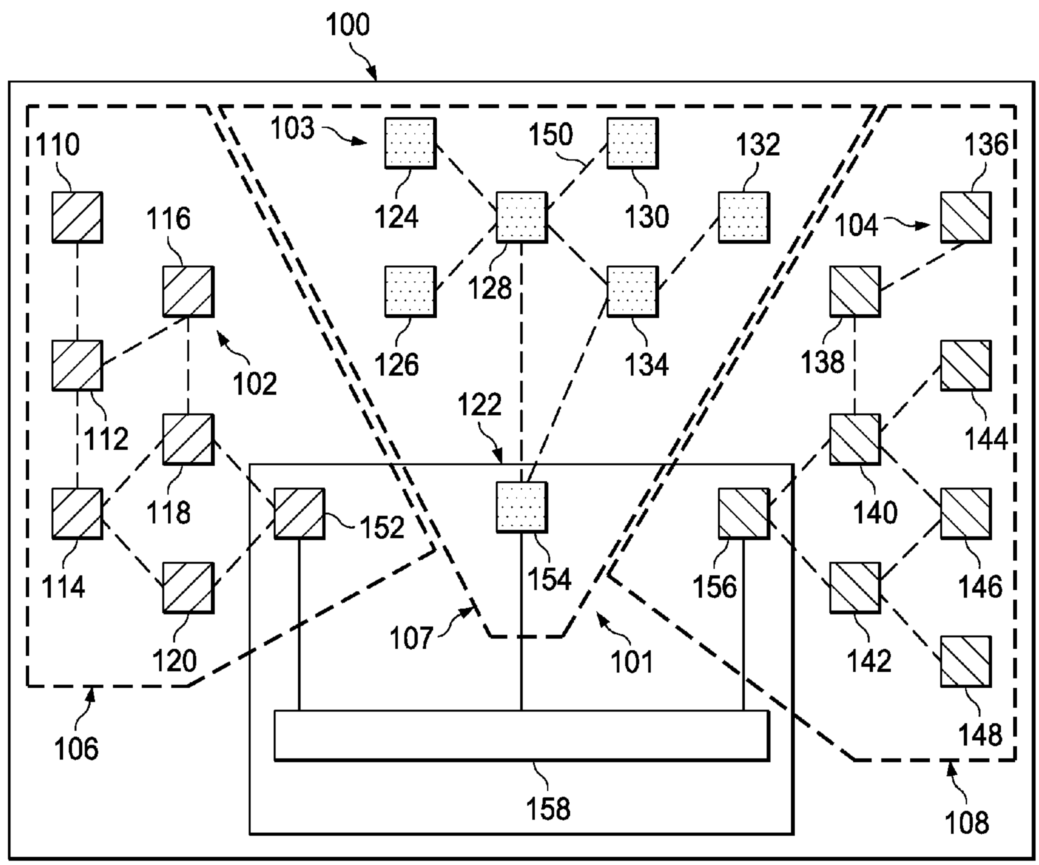
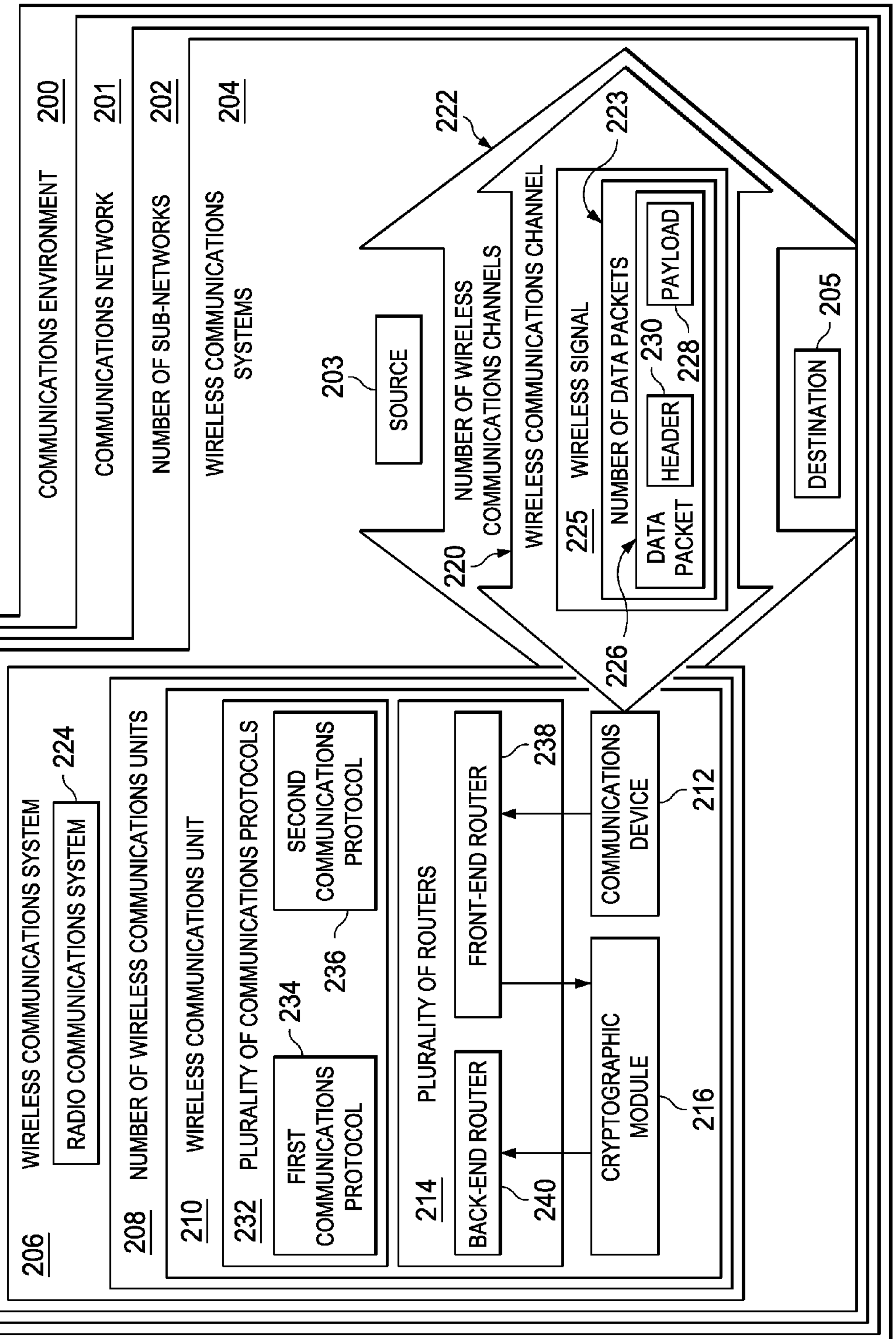

100
103
150
132
136
110
124
130
116
104
128
102
126
134
138
112
122
144
118
152
140
114
154
156
146
107
120
101
142
106
148
158
108

FIG. 1

FIG. 2


COMMUNICATIONS ENVIRONMENT 200
COMMUNICATIONS NETWORK 201
NUMBER OF SUB-NETWORKS 202
WIRELESS COMMUNICATIONS SYSTEMS 204
SOURCE 203
222
NUMBER OF WIRELESS COMMUNICATIONS CHANNELS 220
WIRELESS COMMUNICATIONS CHANNEL
223
WIRELESS SIGNAL 225
NUMBER OF DATA PACKETS
DATA PACKET
HEADER 230
PAYLOAD 228
226
DESTINATION 205
WIRELESS COMMUNICATIONS SYSTEM 206
RADIO COMMUNICATIONS SYSTEM 224
NUMBER OF WIRELESS COMMUNICATIONS UNITS 208
WIRELESS COMMUNICATIONS UNIT 210
PLURALITY OF COMMUNICATIONS PROTOCOLS 232
FIRST COMMUNICATIONS PROTOCOL 234
SECOND COMMUNICATIONS PROTOCOL 236
PLURALITY OF ROUTERS 214
BACK-END ROUTER 240
FRONT-END ROUTER 238
COMMUNICATIONS DEVICE 212
CRYPTOGRAPHIC MODULE 216

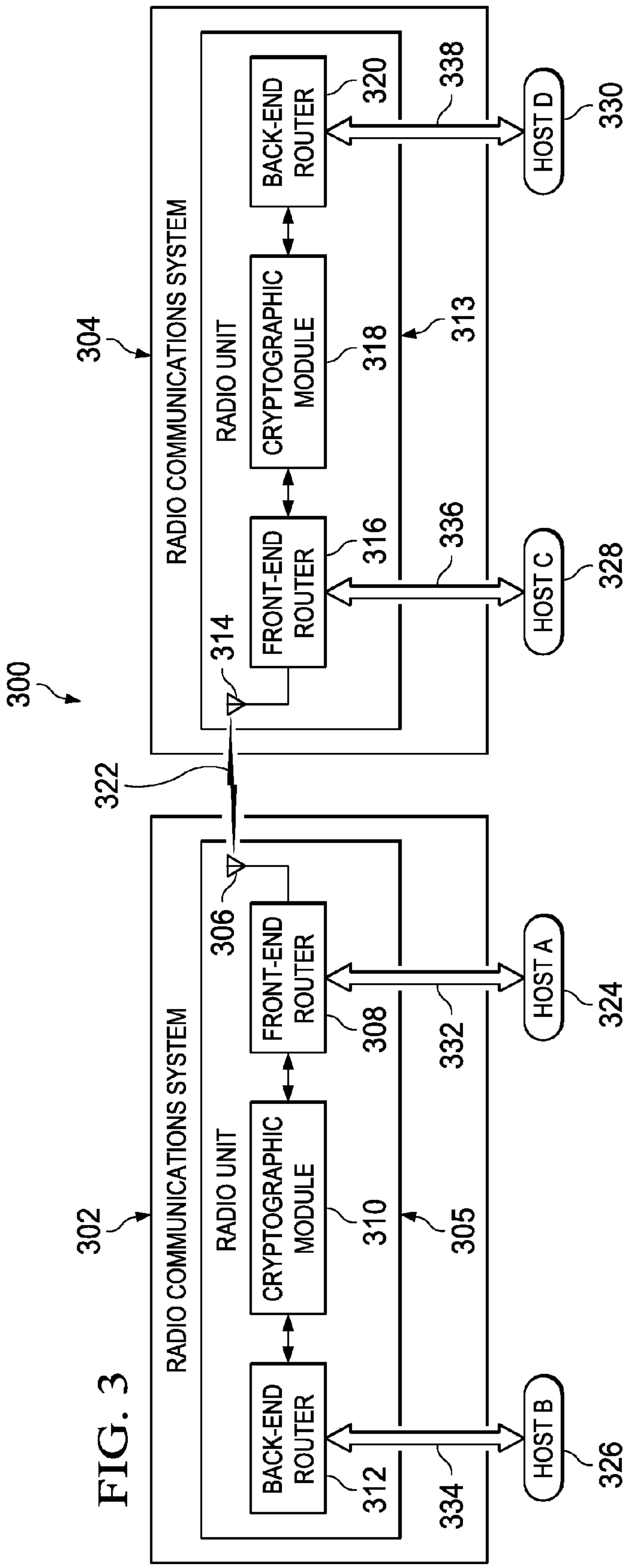
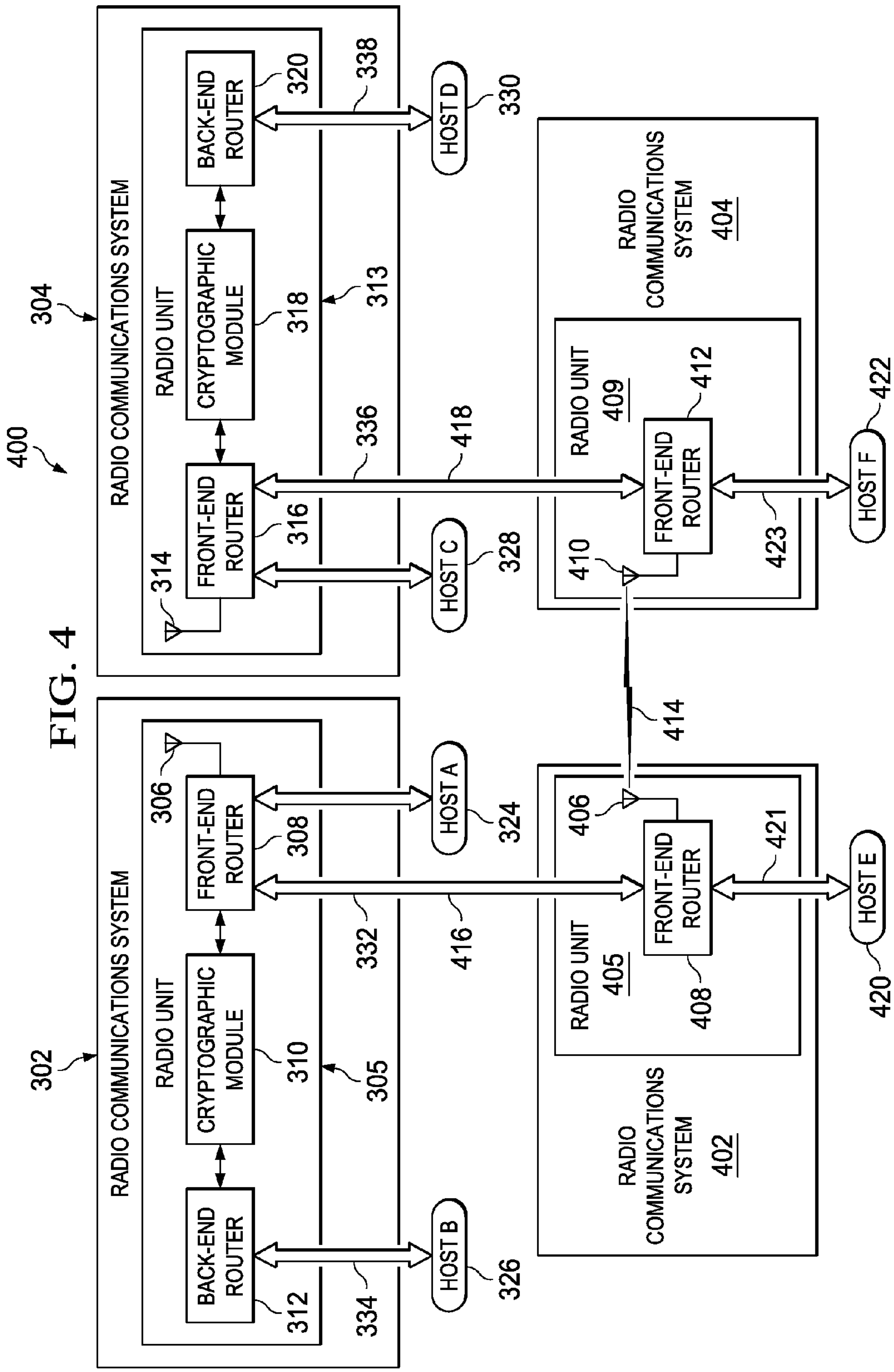

300
302
RADIO COMMUNICATIONS SYSTEM
RADIO UNIT
305
BACK-END ROUTER
312
CRYPTOGRAPHIC MODULE
310
FRONT-END ROUTER
308
306
322
304
RADIO COMMUNICATIONS SYSTEM
RADIO UNIT
313
314
FRONT-END ROUTER
316
CRYPTOGRAPHIC MODULE
318
BACK-END ROUTER
320
HOST A
324
332
HOST B
326
334
HOST C
328
336
HOST D
330
338

FIG. 3


400
304
RADIO COMMUNICATIONS SYSTEM
RADIO UNIT
FRONT-END ROUTER
CRYPTOGRAPHIC MODULE
BACK-END ROUTER
313
314
316
318
320
336
338
HOST C
328
HOST D
330
302
RADIO COMMUNICATIONS SYSTEM
RADIO UNIT
FRONT-END ROUTER
CRYPTOGRAPHIC MODULE
BACK-END ROUTER
305
306
308
310
312
332
334
HOST A
324
HOST B
326
418
416
414
RADIO COMMUNICATIONS SYSTEM
404
RADIO UNIT
409
FRONT-END ROUTER
410
412
423
HOST F
422
RADIO COMMUNICATIONS SYSTEM
402
RADIO UNIT
405
FRONT-END ROUTER
406
408
421
HOST E
420
FIG. 4

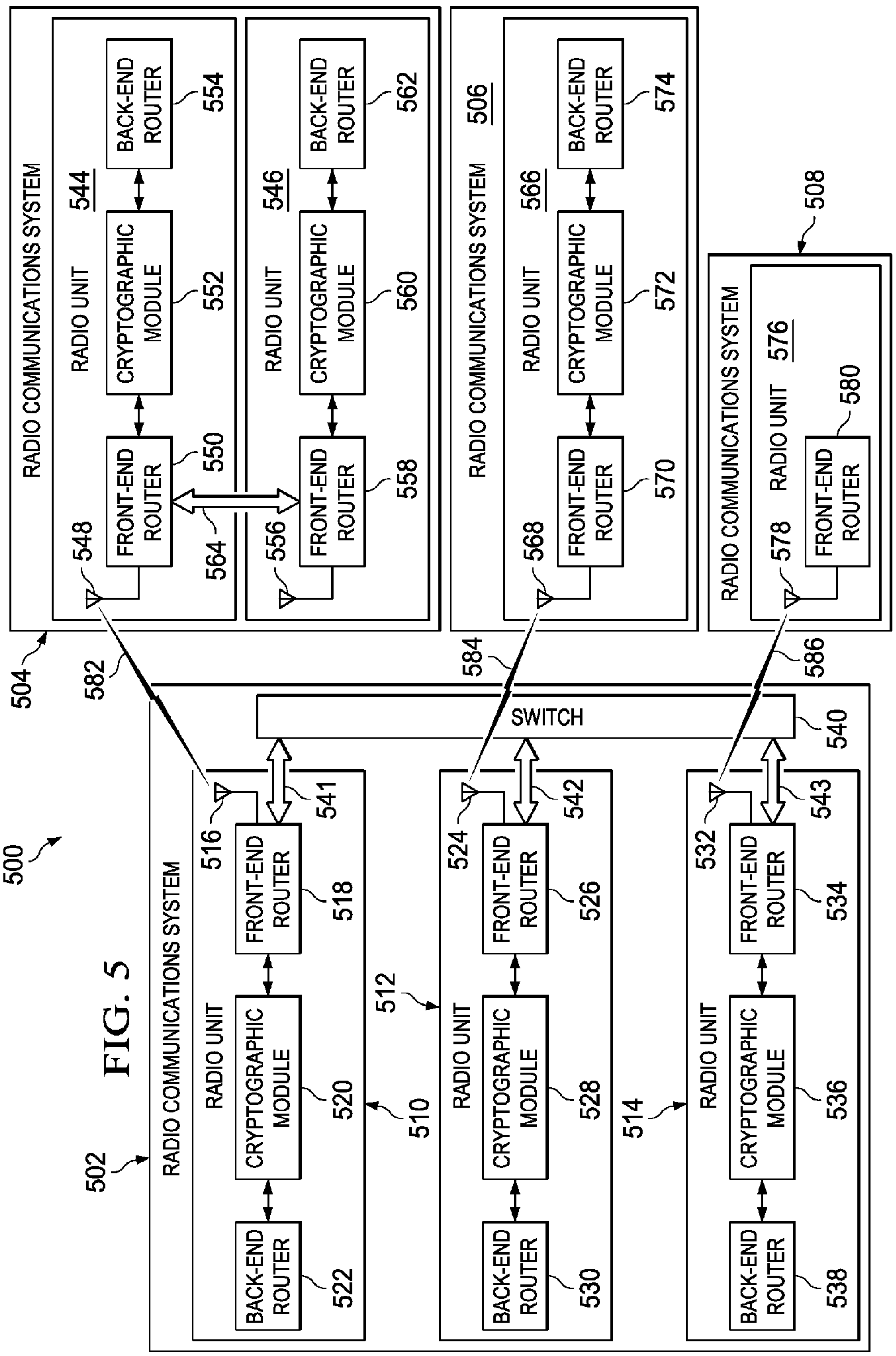

500
502
RADIO COMMUNICATIONS SYSTEM
510
RADIO UNIT
516
FRONT-END ROUTER
518
CRYPTOGRAPHIC MODULE
520
BACK-END ROUTER
522
512
RADIO UNIT
524
FRONT-END ROUTER
526
CRYPTOGRAPHIC MODULE
528
BACK-END ROUTER
530
514
RADIO UNIT
532
FRONT-END ROUTER
534
CRYPTOGRAPHIC MODULE
536
BACK-END ROUTER
538
SWITCH
540
541
542
543
582
584
586
504
RADIO COMMUNICATIONS SYSTEM
RADIO UNIT 544
548
FRONT-END ROUTER
550
CRYPTOGRAPHIC MODULE
552
BACK-END ROUTER
554
564
RADIO UNIT 546
556
FRONT-END ROUTER
558
CRYPTOGRAPHIC MODULE
560
BACK-END ROUTER
562
RADIO COMMUNICATIONS SYSTEM 506
RADIO UNIT 566
568
FRONT-END ROUTER
570
CRYPTOGRAPHIC MODULE
572
BACK-END ROUTER
574
508
RADIO COMMUNICATIONS SYSTEM
RADIO UNIT 576
578
FRONT-END ROUTER
580

FIG. 5

FIG. 6

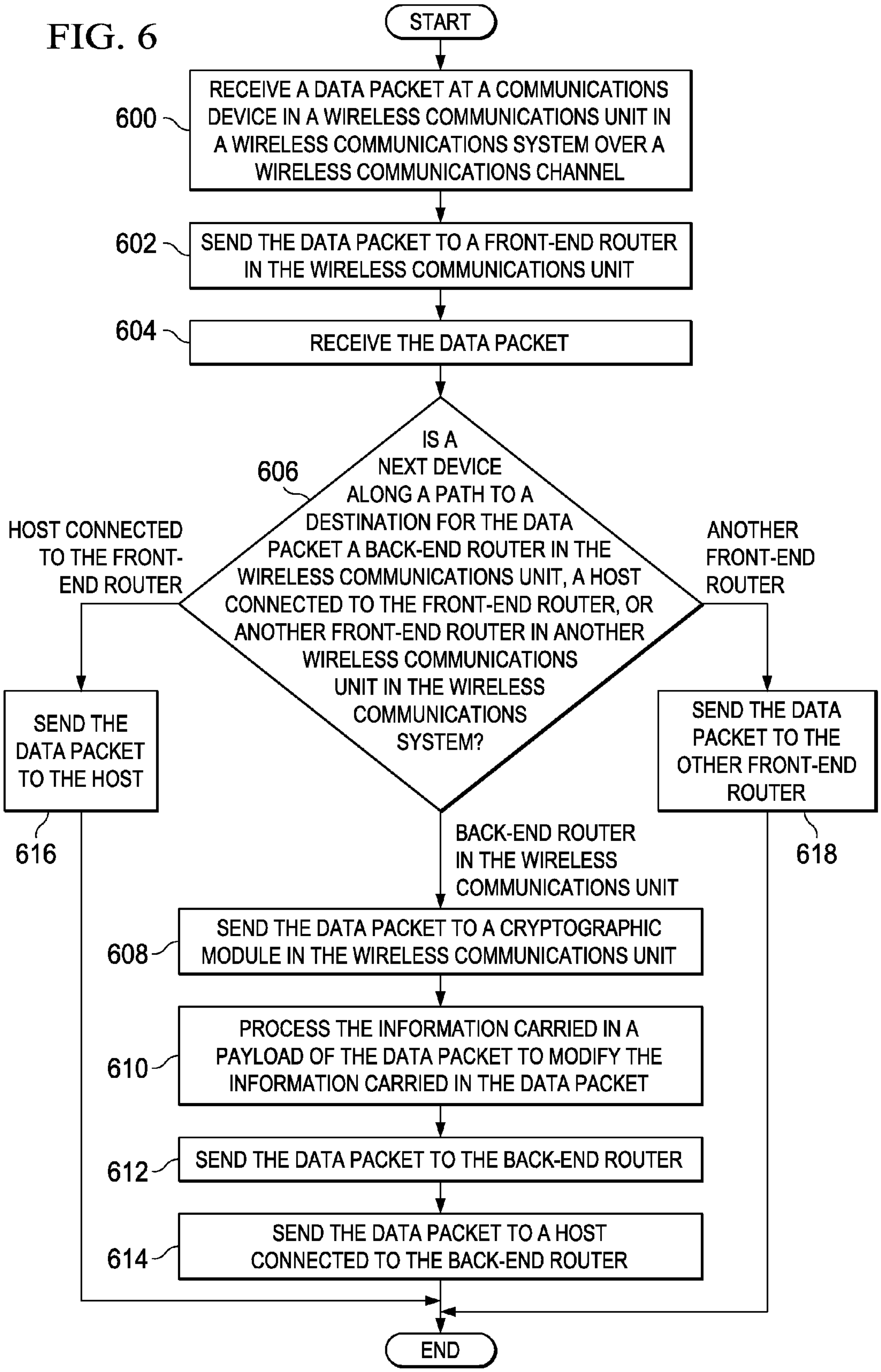
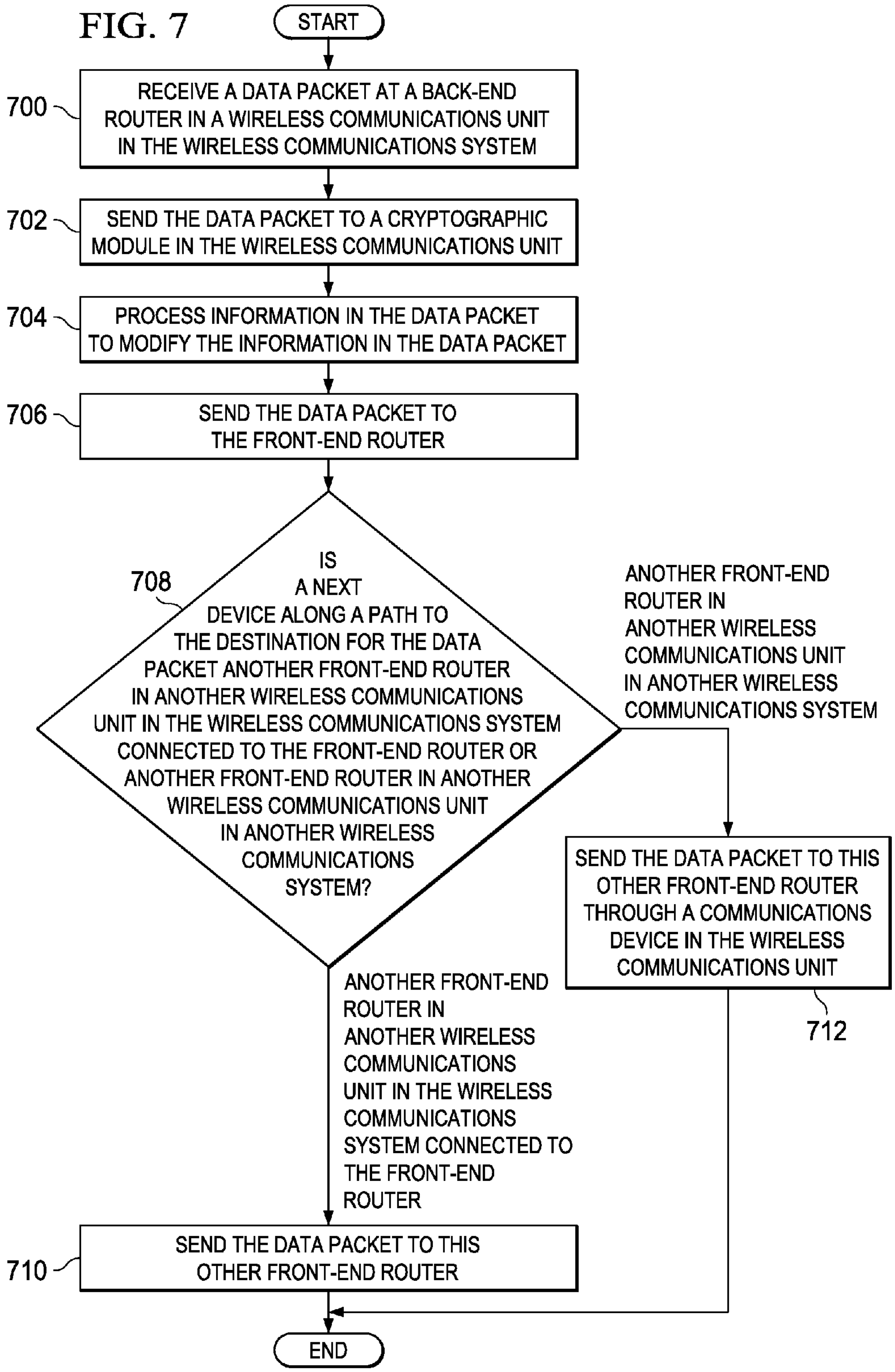

START
600
RECEIVE A DATA PACKET AT A COMMUNICATIONS DEVICE IN A WIRELESS COMMUNICATIONS UNIT IN A WIRELESS COMMUNICATIONS SYSTEM OVER A WIRELESS COMMUNICATIONS CHANNEL
602
SEND THE DATA PACKET TO A FRONT-END ROUTER IN THE WIRELESS COMMUNICATIONS UNIT
604
RECEIVE THE DATA PACKET
606
IS A NEXT DEVICE ALONG A PATH TO A DESTINATION FOR THE DATA PACKET A BACK-END ROUTER IN THE WIRELESS COMMUNICATIONS UNIT, A HOST CONNECTED TO THE FRONT-END ROUTER, OR ANOTHER FRONT-END ROUTER IN ANOTHER WIRELESS COMMUNICATIONS UNIT IN THE WIRELESS COMMUNICATIONS SYSTEM?
HOST CONNECTED TO THE FRONT-END ROUTER
ANOTHER FRONT-END ROUTER
SEND THE DATA PACKET TO THE HOST
616
SEND THE DATA PACKET TO THE OTHER FRONT-END ROUTER
618
BACK-END ROUTER IN THE WIRELESS COMMUNICATIONS UNIT
608
SEND THE DATA PACKET TO A CRYPTOGRAPHIC MODULE IN THE WIRELESS COMMUNICATIONS UNIT
610
PROCESS THE INFORMATION CARRIED IN A PAYLOAD OF THE DATA PACKET TO MODIFY THE INFORMATION CARRIED IN THE DATA PACKET
612
SEND THE DATA PACKET TO THE BACK-END ROUTER
614
SEND THE DATA PACKET TO A HOST CONNECTED TO THE BACK-END ROUTER
END

FIG. 7


START
700
RECEIVE A DATA PACKET AT A BACK-END ROUTER IN A WIRELESS COMMUNICATIONS UNIT IN THE WIRELESS COMMUNICATIONS SYSTEM
702
SEND THE DATA PACKET TO A CRYPTOGRAPHIC MODULE IN THE WIRELESS COMMUNICATIONS UNIT
704
PROCESS INFORMATION IN THE DATA PACKET TO MODIFY THE INFORMATION IN THE DATA PACKET
706
SEND THE DATA PACKET TO THE FRONT-END ROUTER
708
IS A NEXT DEVICE ALONG A PATH TO THE DESTINATION FOR THE DATA PACKET ANOTHER FRONT-END ROUTER IN ANOTHER WIRELESS COMMUNICATIONS UNIT IN THE WIRELESS COMMUNICATIONS SYSTEM CONNECTED TO THE FRONT-END ROUTER OR ANOTHER FRONT-END ROUTER IN ANOTHER WIRELESS COMMUNICATIONS UNIT IN ANOTHER WIRELESS COMMUNICATIONS SYSTEM?
ANOTHER FRONT-END ROUTER IN ANOTHER WIRELESS COMMUNICATIONS UNIT IN ANOTHER WIRELESS COMMUNICATIONS SYSTEM
SEND THE DATA PACKET TO THIS OTHER FRONT-END ROUTER THROUGH A COMMUNICATIONS DEVICE IN THE WIRELESS COMMUNICATIONS UNIT
712
ANOTHER FRONT-END ROUTER IN ANOTHER WIRELESS COMMUNICATIONS UNIT IN THE WIRELESS COMMUNICATIONS SYSTEM CONNECTED TO THE FRONT-END ROUTER
710
SEND THE DATA PACKET TO THIS OTHER FRONT-END ROUTER
END

AD-HOC RADIO COMMUNICATIONS SYSTEM

BACKGROUND INFORMATION

1. Field

The present disclosure relates generally to a communications network and, in particular, to radio communications systems within the communications network. Still more particularly, the present disclosure relates to a method and apparatus for routing data packets based on different communications protocols to the correct destinations for these data packets using the radio communications systems within the communications network.

2. Background

A communications network allows information to be exchanged between different types of devices. As used herein, "exchanging" means sending, receiving, or a combination of the two. For example, information may be wirelessly sent from a source to a destination using a communications network. The source and the destination are devices connected to the communications network through one or more wireless communications systems in the communications network. The information may be wirelessly routed from the source to the destination through one or more wireless communications systems in the communications network.

A radio communications system is an example of one type of wireless communications system. A radio communications system is capable of sending and/or receiving information over a wireless communications channel using a radio frequency (RF) signal. The information may be carried in the radio frequency signal over the wireless communications channel in the form of one or more data packets.

A data packet is a segment of data that typically includes a header and a payload. The payload includes the information being carried in the data packet. The header includes other information such as, for example, a source of the payload, a destination for the payload, a size of the payload, a number of flag binary digits, an identifier for the data packet, and/or other useful information.

Different types of communications protocols are currently available for exchanging information across a communications network. As used herein, a "communications protocol" is a set of procedures to be followed when exchanging information across a communications network. In particular, the communications protocol selected for sending information from a source to a destination may determine the type of data packet formed to carry the information and the manner in which the data packet is routed through the particular communications network.

With some currently available configurations for radio communications systems, multiple wireless communications channels may be established with a radio communications system. Further, the radio communications system may be able to handle information based on multiple communications protocols. However, with these currently available configurations, each communications protocol is set to a different wireless communications channel. For example, the radio communications system may have a different circuitry for each type of communications protocol, with each circuitry required to send and receive information using a different wireless communications channel.

A radio communications system with this type of configuration may be more difficult than desired to reconfigure after assembly has been completed. For example, with this type of configuration, the different circuitries set to the different wireless communications channels may be more complex than desired. Adding a new circuitry or changing a circuitry to handle information based on a new communications protocol may be more difficult than desired. Therefore, it would be desirable to have a method and apparatus that takes into account at least some of the issues discussed above, as well as other possible issues.

SUMMARY

In one illustrative embodiment, a wireless communications system comprises a wireless communications unit. The wireless communications unit comprises a communications device, a back-end router, a cryptographic module connected to the back-end router, and a front-end router connected to the cryptographic module and the communications device. The communications device is configured to exchange information over a single wireless communications channel. The front-end router is configured to perform at least one of sending a first data packet received at the front-end router from the communications device to the back-end router through the cryptographic module and sending a second data packet received at the front-end router from the back-end router through the cryptographic module to the communications device.

In another illustrative embodiment, a communications network comprises a number of sub-networks. A sub-network in the number of sub-networks comprises a group of radio communications systems. A radio communications system in the group of radio communications systems comprises a number of radio communications units. A radio communications unit in the number of radio communications units comprises a communications device, a back-end router, a cryptographic module connected to the back-end router, and a front-end router connected to the cryptographic module and the communications device. The communications device is configured to exchange information over a single wireless communications channel using a radio frequency signal. The front-end router is configured to perform at least one of sending a first data packet received at the front-end router from the communications device to the back-end router through the cryptographic module and sending a second data packet received at the front-end router from the back-end router through the cryptographic module to the communications device.

In yet another illustrative embodiment, a method for exchanging information is present. A data packet is received at a front-end router in a wireless communications unit in a wireless communications system. A next device is identified by the front-end router along a path to a destination for the data packet using a header of the data packet. The data packet is sent from the front-end router to the next device along the path to the destination for the data packet. The next device is selected from one of a back-end router in the wireless communications unit, a communications device in the wireless communications unit, and another front-end router in another wireless communications unit in the wireless communications system. The front-end router and the back-end router are configured to exchange data packets through a cryptographic module.

The features and functions can be achieved independently in various embodiments of the present disclosure or may be combined in yet other embodiments in which further details can be seen with reference to the following description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The novel features believed characteristic of the illustrative embodiments are set forth in the appended claims. The illustrative embodiments, however, as well as a preferred mode of use, further objectives and features thereof, will best be understood by reference to the following detailed description of an illustrative embodiment of the present disclosure when read in conjunction with the accompanying drawings, wherein:

FIG. **1** is an illustration of a communications environment in accordance with an illustrative embodiment;

FIG. **2** is an illustration of a communications environment in the form of a block diagram in accordance with an illustrative embodiment;

FIG. **3** is an illustration of a communications network in accordance with an illustrative embodiment;

FIG. **4** is an illustration of a communications network in accordance with an illustrative embodiment;

FIG. **5** is an illustration of a communications network in accordance with an illustrative embodiment;

FIG. **6** is an illustration of a process for exchanging information, in the form of a flowchart, in accordance with an illustrative embodiment; and

FIG. **7** is an illustration of a process for exchanging information, in the form of a flowchart, in accordance with an illustrative embodiment.

DETAILED DESCRIPTION

The different illustrative embodiments recognize and take into account that it may be desirable to have a radio communications system configured to send and receive information based on different types of communications protocols using a single wireless communications channel. Further, the different illustrative embodiments recognize that it may be desirable to have a wireless communications system with these capabilities that has a desired level of complexity. In particular, a wireless communications system that is simpler and more easily reconfigured as compared to some currently available configurations for radio communications systems may be desirable.

Thus, the different illustrative embodiments provide a wireless communications system configured to receive information over multiple wireless communications channels and route information based on different communications protocols. The wireless communications system provided by the different illustrative embodiments may have a desired level of simplicity and may be easily reconfigurable.

With reference now to FIG. **1**, an illustration of a communications environment is depicted in accordance with an illustrative embodiment. In this illustrative example, communications environment **100** is an example of an environment in which different radio communications systems in communications network **101** may communicate with each other in accordance with an illustrative embodiment.

Communications network **101** includes group of radio communications systems **102**, group of radio communications systems **103**, and group of radio communications systems **104**. As used herein, a "group of" items means one or more items. For example, group of radio communications systems **102** means one or more radio communications systems.

In this illustrative example, group of radio communications systems **102** includes radio communications systems **110**, **112**, **114**, **116**, **118**, **120**, and **122**. These radio communications systems are part of sub-network **106** in communications network **101**. Group of radio communications systems **103** includes radio communications systems **122**, **124**, **126**, **128**, **130**, **132**, and **134**. These radio communications systems are part of sub-network **107** in communications network **101**.

Group of radio communications systems **104** includes radio communications systems **122**, **136**, **138**, **140**, **142**, **144**, **146**, and **148**. These radio communications systems are part of sub-network **108** in communications network **101**. In this manner, radio communications system **122** belongs to each of sub-networks **106**, **107**, and **108**.

The different radio communications systems in communications network **101** communicate with each other using wireless communications channels **150**. As used herein, a "wireless communications channel" is a wireless connection between two wireless communications systems. A wireless communications channel may also be referred to as a wireless communications link. Further, as used herein, a wireless communications channel may only be formed between two wireless communications systems at any given point in time.

In these illustrative examples, one radio communications system in communications network **101** may exchange information with another radio communications system in communications network **101** over a wireless communications channel using a radio frequency (RF) signal. This exchange of information may include, for example, sending information, receiving information, or a combination of the two. In some cases, the sending and receiving of information may be performed at the same time.

The configuration for radio communications system **122** is depicted in FIG. **1** as an example of one implementation for a radio communications system in communications network **101**. As depicted, radio communications system **122** includes radio unit **152**, radio unit **154**, radio unit **156**, and switch **158**.

Radio unit **152** is configured to send information to and/or receive information from other radio communications systems in sub-network **106**. Radio unit **154** is configured to send information to and/or receive information from other radio communications systems in sub-network **107**. Further, radio unit **156** is configured to send information to and/or receive information from other radio communications systems in sub-network **108**.

In this illustrative example, switch **158** is physically connected to radio units **152**, **154**, and **156**. Switch **158** allows these radio units to exchange information with each other. For example, switch **158** may receive information from radio unit **152** and then send this information to radio unit **154**. In this manner, switch **158** allows information to be exchanged across sub-networks **106**, **107**, and **108**. In other words, radio communications system **122** interconnects sub-networks **106**, **107**, and **108**.

The configuration for radio communications system **122** depicted in FIG. **1** may be the same as or different from the configurations for other radio communications systems in communications network **101**. For example, some of these radio communications systems may have only one radio unit, while other wireless communications systems may have two, four, five, or some other suitable number of radio units.

In some cases, a radio communications system may not include a switch. Instead, the radio communications system may have two or more radio units that are physically connected to each other without using a switch or other type of device.

With reference now to FIG. **2**, an illustration of a communications environment in the form of a block diagram is depicted in accordance with an illustrative embodiment. Communications environment **100** in FIG. **1** is an example of one implementation for communications environment **200** in FIG. **2**. Communications environment **200** includes communications network **201**. Communications network **201** is a wireless communications network in these illustrative examples.

Communications network **201** includes number of sub-networks **202**. As used herein, a "number of" items means one or more items. For example, number of sub-networks **202** means one or more sub-networks.

In these illustrative examples, a sub-network in number of sub-networks **202** may take various forms. For example, without limitation, a sub-network in number of sub-networks **202** may take the form of an airborne sub-network, a ground sub-network, the Internet, or some other suitable type of sub-network.

As depicted, number of sub-networks **202** includes wireless communications systems **204**. The portion of wireless communications systems **204** belonging to a particular sub-network in number of sub-networks **202** may be referred to as a group of wireless communications systems. Group of radio communications systems **102** belonging to sub-network **106** in FIG. **1** is an example of one implementation for a group of wireless communications systems belonging to a particular sub-network in number of sub-networks **202**.

Source **203** may send information to destination **205** using one or more of wireless communications systems **204** in communications network **201**. Source **203** is connected to one of wireless communications systems **204**. Further, destination **205** is connected to one of wireless communications systems **204**. Each of these connections may be a wired connection, a wireless connection, or some other suitable type of connection.

In these illustrative examples, wireless communications system **206** is an example of one of wireless communications systems **204**. Wireless communications system **206** comprises number of wireless communications units **208**. Wireless communications unit **210** is an example of a wireless communications unit in number of wireless communications units **208**.

As depicted, wireless communications unit **210** includes communications device **212**, plurality of routers **214**, and cryptographic module **216**. Communications device **212** is configured to form wireless communications channel **220** with a communications device in a wireless communications unit in another wireless communications system in wireless communications systems **204**. Further, communications device **212** is configured to exchange information over wireless communications channel **220**. This information may include, for example, at least one of a message, voice data, audio data, an image, a video, a file, a document, a command, and other suitable types of data.

Communications device **212** may comprise, for example, without limitation, at least one of an antenna, a directional antenna, an omnidirectional antenna, a transmitter, a receiver, a transceiver, a processor unit, a multiplier, an analog to digital converter (ADC), a digital to analog converter (DAC), a modem, and other suitable types of components. As used herein, the phrase "at least one of", when used with a list of items, means different combinations of one or more of the listed items may be used and only one of each item in the list may be needed.

For example, "at least one of item A, item B, and item C" may include, without limitation, item A or item A and item B. This example also may include item A, item B, and item C, or item B and item C. In other examples, "at least one of" may be, for example, without limitation, two of item A, one of item B, and ten of item C; four of item B and seven of item C; or some other suitable combination.

In these illustrative examples, each wireless communications unit in number of wireless communications units **208** in wireless communications system **206** may have a communications device configured to form a wireless communications channel. In this manner, wireless communications channel **220** may be one of number of wireless communications channels **222** that may be formed by number of wireless communications units **208** in wireless communications system **206**.

As depicted, communications device **212** is configured to exchange information over wireless communications channel **220** using wireless signal **225**. Wireless signal **225** may be selected from one of, for example, without limitation, a radio frequency (RF) signal, an optical signal, an infrared signal, an electromagnetic signal, an audio signal, or some other suitable type of wireless signal, depending on the implementation.

When wireless signal **225** is a radio frequency signal, wireless communications unit **210** may be referred to as a radio unit or a radio. Number of wireless communications units **208** may be a number of radio units. When at least one of the wireless communications units in number of wireless communications units **208** in wireless communications system **206** is a radio unit, wireless communications system **206** may be referred to as radio communications system **224**. In this manner, a sub-network in number of sub-networks **202** may be formed using a group of radio communications systems.

In these illustrative examples, information may be carried in wireless signal **225** over wireless communications channel **220** in the form of number of data packets **223**. As used herein, a "data packet", such as a data packet in number of data packets **223**, is a segment of data comprising one or more pieces of information that is being sent from or received at a communications system over a communications channel.

Data packet **226** is an example of one of number of data packets **223**. Data packet **226** may be, for example, a data packet that is being routed from source **203** to destination **205** across communications network **201**. Wireless communications system **206** may be one point along a path from source **203** to destination **205** through communications network **201**. This path may also be referred to as a route.

In one illustrative example, data packet **226** comprises payload **228** and header **230**. Payload **228** includes the information being carried in data packet **226**. Header **230** includes additional information such as, for example, at least one of source **203** of payload **228**, destination **205** for payload **228**, a size of payload **228**, a number of flag binary digits, an identifier for data packet **226**, and other useful information. In some cases, data packet **226** may be referred to as a datagram, a data segment, a data block, a data cell, or a data frame, depending on the implementation.

Further, in these illustrative examples, data packet **226** is formed and routed through communications network **201** based on one of plurality of communications protocols **232**. As used herein, a "communications protocol", such as one of plurality of communications protocols **232**, is a set of procedures to be followed when exchanging information in communications network **201**. For example, a communications protocol may include procedures for at least one of signaling, authentication, error detection, error correction, and other suitable types of functions. In some cases, a communications protocol may define the syntax, semantics, and/or synchronization with which a data packet is formed and routed through communications network **201**.

In one illustrative example, plurality of communications protocols **232** includes first communications protocol **234** and second communications protocol **236**. First communications protocol **234** may be, for example, without limitation, a security protocol for handling information belonging to a first security category. Second communications protocol **236** may be, for example, without limitation, a security protocol for handling information belonging to a second security category.

As used herein, a "security category" is a category for information requiring a particular level of security or protection. For example, the first security category may correspond to a level of security that is lower than the level of security corresponding to the second security category. In other words, access to information belonging to the second security category may require a higher level of clearance or authorization than access to information belonging to the first security category.

As one illustrative example, when the information carried in payload **228** belongs to the first security category, data packet **226** is formed based on first communications protocol **234**. In this example, both the information carried in payload **228** and the additional information in header **230** are left unencrypted. This type of data packet **226** may be referred to as an unencrypted data packet.

In another illustrative example, when the information carried in payload **228** belongs to the second security category, data packet **226** is formed based on second communications protocol **236**. In this example, the information carried in payload **228** is encrypted. However, the additional information in header **230** is left unencrypted. This type of data packet **226** may be referred to as an encrypted data packet. In this manner, the additional information in header **230** may always be left unencrypted regardless of whether the information carried in payload **228** belongs to the first security category or the second security category.

As depicted, plurality or routers **214** includes front-end router **238** and back-end router **240**. A "router", as used herein, such as front-end router **238** and back-end router **240**, is a hardware device configured to forward a data packet to a next device along a path to a destination for the data packet.

Further, a router may be connected to one or more hosts. A "host", as used herein, is a device configured to connect to a sub-network in number of sub-networks **202** in communications network **201** through a router. A host may take various forms. For example, a host may take the form of a computer, a notebook computer, a tablet computer, a mobile phone, a data processing system, a printer, a scanner, a fax machine, an analog radio communications unit, a digital radio, a microphone, a speaker, a display system, a head-mounted display system, or some other suitable type of device. In some cases, a host may be referred to as a client system or a server system.

A host may be connected to a router using a physical connection such as, for example, a wire, a cable, or some other suitable physical medium. Typically, a host is connected to a router at a communications port for the router using a cable. Of course, in other illustrative examples, a host may be connected to a router using a wireless communications channel, an optical communication channel, or some other suitable type of communication channel or link.

Each of front-end router **238** and back-end router **240** may be connected to one or more hosts. Any of these hosts may be source **203** of data packet **226** or destination **205** for data packet **226**. A host connected to front-end router **238** is authorized to have access to information belonging to a first security category. A host connected to back-end router **240** is authorized to have access to information belonging to a second security category. In some cases, a host connected to back-end router **240** may be authorized to have access to information belonging to both the first security category and the second security category.

Additionally, front-end router **238** is connected to communications device **212** and cryptographic module **216**. Back-end router **240** is connected to cryptographic module **216**. These connections with front-end router **238** and back-end router **240** may be physical connections. Front-end router **238** and back-end router **240** may exchange data packets with each other through cryptographic module **216**.

In these illustrative examples, any data packets received at wireless communications unit **210** and/or sent from wireless communications unit **210** must pass through front-end router **238**. As one illustrative example, when communications device **212** receives a first data packet over wireless communications channel **220**, communications device **212** sends the first data packet to front-end router **238**. In this illustrative example, the first data packet may be data packet **226**.

Front-end router **238** uses header **230** of data packet **226** to identify a next device along the path to destination **205** for data packet **226**. The next device may be, for example, back-end router **240**, a host connected to front-end router **238**, another front-end router in another wireless communications unit in number of wireless communications units **208** in wireless communications system **206**, or another front-end router in another wireless communications unit in another wireless communications system in wireless communications systems **204**.

Data packet **226** is to be forwarded to back-end router **240** when data packet **226** is an encrypted data packet. When data packet **226** is to be forwarded to back-end router **240**, front-end router **238** sends data packet **226** to back-end router **240** through cryptographic module **216**. In particular, front-end router **238** sends data packet **226** to cryptographic module **216**.

Cryptographic module **216** processes the information carried in payload **228** of data packet **226** to modify the information in payload **228**. For example, when the information carried in payload **228** of data packet **226** is encrypted, cryptographic module **216** decrypts this information such that data packet **226** becomes an unencrypted data packet.

Cryptographic module **216** then sends the unencrypted data packet to back-end router **240**. In response to receiving data packet **226**, back-end router **240** uses header **230** to identify a next device along the path to destination **205** for data packet **226**. This next device may be, for example, a host connected to back-end router **240**.

In another illustrative example, when communications device **212** sends a second data packet from wireless communications unit **210**, this second data packet is always received at communications device **212** from front-end router **238**. This second data packet may be data packet **226** in this example. For example, front-end router **238** may receive data packet **226** from one of a host connected to front-end router **238**, another front-end router in another wireless communications unit in number of wireless communications units **208** in wireless communications system **206**, or back-end router **240**.

Front-end router **238** may receive data packet **226** from back-end router **240** through cryptographic module **216**. For example, a host connected to back-end router **240** may send data packet **226** to back-end router **240**. Back-end router **240** uses header **230** to determine that data packet **226** is to be forwarded to front-end router **238**. In particular, back-end router **240** sends data packet **226** to front-end router **238** through cryptographic module **216**.

In response to receiving data packet **226** from back-end router **240**, cryptographic module **216** processes the information carried in payload **228** of data packet **226** to modify this information. For example, when the information carried in payload **228** of data packet **226** is unencrypted, cryptographic module **216** encrypts this information such that data packet **226** becomes an encrypted data packet.

Cryptographic module **216** then sends this encrypted data packet to front-end router **238**. Front-end router **238** may then route data packet **226** to the next device along the path to destination **205** for data packet **226** through communications device **212**.

In these illustrative examples, cryptographic module **216** may comprise hardware, software, or a combination of the two. For example, cryptographic module **216** may be implemented in a processor unit within wireless communications unit **210**. When hardware is employed, the hardware may include circuits that perform the operations for cryptographic module **216**.

In these illustrative examples, the hardware may take the form of a circuit system, an integrated circuit, an application specific integrated circuit (ASIC), a programmable logic device, or some other suitable type of hardware configured to perform a number of operations. With a programmable logic device, the device is configured to perform the number of operations. The device may be reconfigured at a later time or may be permanently configured to perform the number of operations.

Examples of programmable logic devices include, for example, a programmable logic array, a programmable array logic, a field programmable logic array, a field programmable gate array, and other suitable hardware devices. Additionally, the processes may be implemented in organic components integrated with inorganic components and/or may be comprised entirely of organic components excluding a human being.

Additionally, cryptographic module **216** may perform other functions in addition to or in place of encrypting and decrypting information. For example, without limitation, cryptographic module **216** may also be configured to perform at least one of digital key exchange, digital key management, message authentication, and/or other suitable functions. Cryptographic module **216** may be configured to perform any function that manages a level of security for information.

In these illustrative examples, all information that is to be sent from a host connected to back-end router **240** in wireless communications system **206** to another wireless communications system must first be sent to cryptographic module **216** and encrypted. Cryptographic module **216** then sends the encrypted information to front-end router **238**. Further, all information received at front-end router **238** from communications device **212** that is to be sent to a host connected to back-end router **240** must first pass through cryptographic module **216** for decryption.

With front-end router **238** configured to send information to and receive information from back-end router **240** using cryptographic module **216**, back-end router **240** may not need to be connected to a separate communications device that has established a separate communication channel. Hosts connected to both front-end router **238** and back-end router **240** may send information from and receive information at wireless communications unit **210** through the single wireless communications channel **220** formed by communications device **212**.

In this manner, any number of different scenarios may be present for handling the sending and/or receiving of information by wireless communications unit **210** in wireless communications system **206**. Examples of the different types of scenarios for the exchange of information between different wireless communications systems are described in greater detail in FIGS. **3-5**. Further, different types of configurations for a wireless communications system are depicted in FIGS. **3-5**.

Further, wireless communications system **206** may be reconfigurable. For example, one or more of number of wireless communications units **208** may be removed and/or replaced, while wireless communications system **206** is in use, based on the needs of the system or user using wireless communications system **206**. Further, one or more additional wireless communications units may be added to wireless communications system **206**. In this manner, wireless communications system **206** may be referred to as an ad-hoc wireless communications system. When wireless communications system **206** is a radio communications system, the radio communications system may be referred to as an ad-hoc radio communications system.

In these illustrative examples, wireless communications systems **204** may be associated with a platform. When one component is "associated" with another component, the association is a physical association in these depicted examples. For example, a first component, such as wireless communications system **204**, may be considered to be associated with a second component, such as a platform, by being secured to the second component, bonded to the second component, mounted to the second component, welded to the second component, fastened to the second component, and/or connected to the second component in some other suitable manner.

The first component also may be connected to the second component using a third component. The first component may also be considered to be associated with the second component by being formed as part of and/or an extension of the second component.

Wireless communications system **204** may be associated with a platform. This platform may take various forms. For example, without limitation, the platform may be selected from one of an aerospace vehicle, an unmanned aerial vehicle (UAV), an aircraft, a spacecraft, a ground vehicle, an unmanned ground vehicle (UGV), a ship, a submarine, a building, a manmade structure, a satellite, a tower, a physical enclosure, a manpack, a handheld platform, or some other suitable type of platform. In this manner, the platform may be mobile, stationary, portable, or some combination of these three.

In some cases, the platform may be configured to provide power and other capabilities and/or features to wireless communications system **206**. For example, the platform may provide protection from an environment external to wireless communications system **206**.

The illustration of communications environment **200** in FIG. **2** is not meant to imply physical or architectural limitations to the manner in which an illustrative embodiment may be implemented. Other components in addition to or in place of the ones illustrated may be used. Some components may be optional. Additionally, the blocks in FIG. **2** are presented to illustrate some functional components. One or more of these blocks may be combined, divided, or combined and divided into different blocks when implemented in an illustrative embodiment.

In some illustrative examples, plurality of routers **214** may include one or more routers in addition to front-end router **238** and back-end router **240**. In other illustrative examples, plurality of routers **214** may be configured to handle information based on one or more communications protocols in addition to first communications protocol **234** and second communications protocol **236**.

In some cases, two wireless communications units in number of wireless communications units **208** in wireless communications system **206** may each have a front-end router. These front-end routers may be connected to each other using a wired connection or some other suitable type of medium. In one illustrative example, a wire or cable may be used to connect a communications port for a particular front-end router to the communications port for another front-end router.

In yet another illustrative example, a wireless communications unit in number of wireless communications units **208** may have only a front-end router and may not have a back-end router or a cryptographic module. This front-end router may be connected to front-end router **238**.

In some cases, a data packet, such as data packet **226** may be managed based on more than one communications protocol. For example, data packet **226** may be received and handled at front-end router **238** based on one communications protocol. However, cryptographic module **216** may handle data packet **226** according to a different communications protocol. This communications protocol may be, for example, an encryption protocol.

With reference now to FIG. **3**, an illustration of a communications network is depicted in accordance with an illustrative embodiment. Communications network **300** in FIG. **3** is an example of one implementation for communications network **201** in FIG. **2**. Communications network **300** includes radio communications system **302** and radio communications system **304**. These radio communications systems are examples of implementations for radio communications system **224** in FIG. **2**.

In this illustrative example, radio communications system **302** includes radio unit **305**. Radio unit **305** includes communications device **306**, front-end router **308**, cryptographic module **310**, and back-end router **312**. Radio communications system **304** includes radio unit **313**. Radio unit **313** includes communications device **314**, front-end router **316**, cryptographic module **318**, and back-end router **320**.

As depicted, wireless communications channel **322** is established between communications device **306** and communications device **314**. Information may be exchanged between radio communications system **302** and radio communications system **304** using wireless communications channel **322**.

In this illustrative example, host A **324** is connected to front-end router **308** in radio unit **305** through physical connection **332**. Host B **326** is connected to back-end router **312** in radio unit **305** through physical connection **334**. Further, host C **328** is connected to front-end router **316** in radio unit **313** through physical connection **336**. Host D **330** is connected to back-end router **320** in radio unit **313** through physical connection **338**.

Host A **324**, host B **326**, host C **328**, and host D **330** may communicate with each other using radio communications system **302** and radio communications system **304**. For example, host A **324** may need to send a data packet to host C **328**. In other words, host A **324** may be the source of the data packet and host C **328** may be the destination for the data packet.

Host A **324** first sends the data packet to front-end router **308** in radio unit **305**. Front-end router **308** uses the header of the data packet to determine that host C **328** is the destination for the data packet. Further, front-end router **308** uses the header of the data packet and in some cases, a routing table, to determine that the next device along the path to the destination for the data packet is front-end router **316** in radio unit **313**.

Front-end router **308** sends the data packet to front-end router **316** through communications device **306**. In particular, communications device **306** sends the data packet to communications device **314** over wireless communications channel **322**. Communications device **314** sends the data packet to front-end router **316**. Front-end router **316** uses the header of the data packet to determine that the destination for the data packet is host C **328**. Front-end router **316** then sends the data packet to host C **328**.

In another illustrative example, host B **326** may need to send a data packet to host D **330** with a desired level of security. Host B **326** may be a source of the data packet and host D **330** may be a destination for the data packet. Host B **326** may need to send a data packet to host D **330** in which the information carried in the payload of the data packet is encrypted when the data packet is sent over wireless communications channel **322**.

In this example, host B **326** sends an unencrypted data packet to back-end router **312**. Back-end router **312** then sends the unencrypted data packet to cryptographic module **310**. Cryptographic module **310** encrypts the information carried in the payload of the data packet to form an encrypted data packet. Cryptographic module **310** then sends this encrypted data packet to front-end router **308**. Front-end router **308** uses the header of the encrypted data packet to determine that the next device along the path to the destination for the encrypted packet is front-end router **316** in radio unit **313**.

Front-end router **308** sends the encrypted data to front-end router **316** through communications device **306**. In particular, communications device **306** sends the encrypted data packet to communications device **314** over wireless communications channel **322**. In response to receiving the encrypted data packet, communications device **314** sends the encrypted data packet to front-end router **316**. Front-end router **316** uses the header of the encrypted data packet to determine that the next device along the path to the destination for the encrypted data packet is back-end router **320**.

Consequently, front-end router **316** sends the encrypted data packet to cryptographic module **318**. Cryptographic module **318** decrypts the information carried in the payload of the encrypted data packet to recover the original unencrypted data packet formed by host B **326**. Cryptographic module **318** then sends this unencrypted data packet to back-end router **320**. Back-end router **320** uses the header of the unencrypted data packet to determine that host D **330** is the destination for the data packet. Back-end router **320** then forwards the unencrypted data packet to host D **330**.

With reference now to FIG. **4**, an illustration of a communications environment is depicted in accordance with an illustrative embodiment. In this illustrative example, radio communications system **402** and wireless communications system **404** have been added to communications network **300** from FIG. **3**.

As depicted, radio communications system **402** includes radio unit **405**. Radio unit **405** includes communications device **406** and front-end router **408**. Radio communications system **402** includes radio unit **409**. Radio unit **409** includes communications device **410** and front-end router **412**. Wireless communications channel **414** has been established between communications device **406** and communications device **410**.

As depicted, front-end router **308** and front-end router **408** are connected through physical connection **416**. Further, front-end router **316** and front-end router **412** are connected through physical connection **418**. Additionally, host E **420** is connected to front-end router **408** through physical connection **421** and host F **422** is connected to back-end router **412** through physical connection **423**.

In this illustrative example, wireless communications channel **322** from FIG. **3** has not been established between communications device **306** and communications device **314**. Instead, radio unit **305** and radio unit **313** may communicate with each other using radio unit **405** and radio unit **409**.

In one illustrative example, host A **324** may send a data packet to front-end router **308** in radio unit **305** over physical connection **332**. Front-end router **308** uses the header of the data packet to identify the next device along the path to the destination for the data packet. When the next device along this path is front-end router **408** in radio unit **405**, front-end router **308** sends the data packet directly to front-end router **408** using physical connection **416**.

Front-end router **408** then uses the header of the data packet to identify the next device along the path to the destination for the data packet. In some cases, the next device along the path may be the destination for the path. This destination may be host E **420**. Front-end router **408** may then send the data packet to host E **420** using physical connection **421**.

However, in other cases, the next device along the path may be front-end router **412** in radio unit **409**. In these cases, front-end router **408** sends the data packet to communications device **406**, which in turn, sends the data packet to communications device **410** over wireless communications channel **414**. Communications device **410** sends the data packet to front-end router **412**.

Front-end router **412** uses the header of the data packet to identify the next device along the path to the destination for the data packet. If the next device along the path is host F **422**, front-end router **412** sends the data packet to host F **422** using physical connection **423**. In some cases, the next device may be front-end router **316** in radio communications system **302**. In these cases, front-end router **412** sends the data packet directly to front-end router **316** using physical connection **418**. Front-end router **316** may determine that host C **328** is the destination for the data packet using the header of the data packet. Front-end router **316** sends the data packet to host C **328** using physical connection **336**.

In another illustrative example, host B **326** may send a data packet to host D **330** using radio units **305**, **405**, **409**, and **313**. For example, host B **326** may send the data packet to back-end router **312** over physical connection **334**. Back-end router **312** sends the data packet to cryptographic module **310**. Cryptographic module **310** encrypts the information carried in the payload of the data packet and then sends the encrypted data packet to front-end router **308**.

The encrypted data packet is then sent from front-end router **308** to front-end router **408** over physical connection **416**, from front-end router **408** to communications device **406**, from communications device **406** to communications device **410** over wireless communications channel **414**, from communications device **410** to front-end router **412**, from front-end router **412** to front-end router **316** over physical connection **418**, and from front-end router **316** to cryptographic module **318**.

Cryptographic module **318** decrypts the information carried in the payload of the encrypted data packet to recover the initial data packet generated by host B **326**. Cryptographic module **318** sends this unencrypted data packet to back-end router **320**. Back-end router **320** forwards the unencrypted data packet to host D **330**.

The hosts illustrated as having connections to the different radio units in FIGS. **3-4** may take a number of different forms. These hosts may take the form of, for example, without limitation, laptop computers, tablet computers, computers integrated into vehicles, mobile phones, speakers, headphones, servers, and/or other suitable types of hosts.

With reference now to FIG. **5**, an illustration of a communications network is depicted in accordance with an illustrative embodiment. Communications network **500** in FIG. **5** is an example of one implementation for communications network **201** in FIG. **2**. As depicted, communications network **500** includes radio communications system **502**, radio communications system **504**, radio communications system **506**, and radio communications system **508**.

Radio communications system **502** includes radio unit **510**, radio unit **512**, and radio unit **514**. Radio unit **510** includes communications device **516**, front-end router **518**, cryptographic module **520**, and back-end router **522**. Radio unit **512** includes communications device **524**, front-end router **526**, cryptographic module **528**, and back-end router **530**. Radio unit **514** includes communications device **532**, front-end router **534**, cryptographic module **536**, and back-end router **538**.

Additionally, radio communications system **502** includes switch **540**. Switch **540** connects radio unit **510**, radio unit **512**, and radio unit **514** to each other. In particular, front-end router **518** is connected to switch **540** by physical connection **541**. Front-end router **526** is connected to switch **540** by physical connection **542**. Front-end router **534** is connected to switch **540** by physical connection **543**. Information may be exchanged between radio unit **510**, radio unit **512**, and radio unit **514** using switch **540**.

Further, radio communications system **504** includes radio unit **544** and radio unit **546**. Radio unit **544** includes communications device **548**, front-end router **550**, cryptographic module **552**, and back-end router **554**. Radio unit **546** includes communications device **556**, front-end router **558**, cryptographic module **560**, and back-end router **562**. Front-end router **558** and front-end router **550** are connected through physical connection **564**.

Radio communications system **506** includes radio unit **566**. Radio unit **566** includes communications device **568**, front-end router **570**, cryptographic module **572**, and back-end router **574**. Radio communications system **508** includes radio unit **576**. Radio unit **576** includes communications device **578** and front-end router **580**.

In this illustrative example, wireless communications channel **582** has been established between communications device **516** and communications device **548**. Wireless communications channel **584** has been established between communications device **524** and communications device **568**. Wireless communications channel **586** has been established between communications device **532** and communications device **578**.

Data packets may be exchanged between radio communications systems **502**, **504**, **506**, and **508** in a number of different ways. In one illustrative example, a data packet received at communications device **516** from communications device **548** may be sent to front-end router **518**. Front-end router **518** may determine that the data packet is targeted for a host connected to front-end router **570**.

Consequently, front-end router **518** sends the data packet to switch **540**, which in turn, sends the data packet to front-end router **526**. Front-end router **526** then sends the data packet to communications device **524**, which in turn, sends the data packet to communications device **568**. Communications device **568** may then send the data packet to front-end router **570**. Front-end router **570** forwards the data packet to the correct host.

The flow of information between the different radio communications systems in the different communications networks described in FIGS. **3-5** and the configurations for the different radio communications systems in FIGS. **3-5** are only examples of some types of information flow and possible configurations. Other types of flows may be used and other configurations may be implemented in other illustrative examples.

The illustrations of communications network **300** in FIGS. **3-4** and communications network **500** in FIG. **5** are not meant to imply physical or architectural limitations to the manner in which an illustrative embodiment may be implemented. Other components in addition to or in place of the ones illustrated may be used. Some components may be optional.

Further, the different components illustrated in FIG. **1** and FIGS. **3-5** may be combined with components in FIG. **2**, used with components in FIG. **2**, or a combination of the two. Additionally, some of the components in FIG. **1** and FIGS. **3-5** may be illustrative examples of how components shown in block form in FIG. **2** may be implemented as physical components.

Turning now to FIG. **6**, an illustration of a process for exchanging information, in the form of a flowchart, is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **6** may be implemented in a communications environment such as communications environment **200** in FIG. **2**. For example, this process may be implemented to exchange information in a communications network such as communications network **201** in FIG. **2**. The process illustrated in FIG. **6** may be implemented using, for example, wireless communications system **206** in FIG. **2**.

The process begins by receiving a data packet at a communications device in a wireless communications unit in a wireless communications system over a wireless communications channel (operation **600**). The process then sends the data packet to a front-end router in the wireless communications unit (operation **602**).

The front-end router receives the data packet (operation **604**). Thereafter, the front-end router determines whether a next device along a path to a destination for the data packet is a back-end router in the wireless communications unit, a host connected to the front-end router, or another front-end router in another wireless communications unit in the wireless communications system (operation **606**). In operation **606**, the process identifies the next device along the path to the destination for the data packet using a header of the data packet.

If the next device is a back-end router in the wireless communications unit, the front-end router sends the data packet to a cryptographic module in the wireless communications unit (operation **608**). Thereafter, the cryptographic module processes the information carried in a payload of the data packet to modify the information carried in the data packet (operation **610**). In one illustrative example, when the information carried in the payload of the data packet is encrypted, the cryptographic module decrypts the information to form an unencrypted data packet.

The cryptographic module then sends the data packet to the back-end router (operation **612**). The back-end router sends the data packet to a host connected to the back-end router (operation **614**), with the process terminating thereafter.

With reference again to operation **606**, if the next device is a host connected to the front-end router, the front-end router sends the data packet to the host (operation **616**), with the process terminating thereafter. The host connected to the front-end router may have a lower security clearance than the host connected to the back-end router.

With reference again to operation **606**, if the next device is another front-end router in another wireless communications unit in the wireless communications system, the front-end router sends the data packet to the other front-end router (operation **618**), with the process terminating thereafter. This other front-end router may then forward the data packet to a next device accordingly.

With reference now to FIG. **7**, an illustration of a process for exchanging information, in the form of a flowchart, is depicted in accordance with an illustrative embodiment. The process illustrated in FIG. **6** may be implemented in a communications environment such as communications environment **200** in FIG. **2**. For example, this process may be implemented to exchange information in a communications network such as communications network **201** in FIG. **2**. The process illustrated in FIG. **6** may be implemented using, for example, wireless communications system **206** in FIG. **2**.

The process begins by receiving a data packet at a back-end router in a wireless communications unit in the wireless communications system (operation **700**). The back-end router sends the data packet to a cryptographic module in the wireless communications unit (operation **702**).

The cryptographic module processes information in the data packet to modify the information in the data packet (operation **704**). In particular, in operation **704** when the information carried in a payload of the data packet is unencrypted, the cryptographic module encrypts the information in the payload of the data packet to form an encrypted data packet.

The cryptographic module then sends the data packet to the front-end router (operation **706**). The front-end router determines whether a next device along a path to the destination for the data packet is another front-end router in another wireless communications unit in the wireless communications system connected to the front-end router or another front-end router in another wireless communications unit in another wireless communications system (operation **708**).

If the next device is another front-end router in another wireless communications unit in the wireless communications system connected to the front-end router, the front-end router sends the data packet to this other front-end router (operation **710**), with the process terminating thereafter.

Otherwise, if the next device is another front-end router in another wireless communications unit in another wireless communications system, the front-end router sends the data packet to this other front-end router through a communications device in the wireless communications unit (operation **712**), with the process terminating thereafter. In particular, in operation **712**, the communications device sends the data packet to the other front-end router over a wireless communications channel.

The flowcharts, information flows, and block diagrams in the different depicted embodiments illustrate the architecture, functionality, and operation of some possible implementations of apparatus and methods in an illustrative embodiment. In this regard, each block in the flowcharts, information flows, or block diagrams may represent a module, segment, function, and/or a portion of an operation or step. For example, one or more of the blocks may be implemented as program code, in hardware, or a combination of the program code and hardware. When implemented in hardware, the hardware may, for example, take the form of integrated circuits that are manufactured or configured to perform one or more operations in the flowcharts or block diagrams.

In some alternative implementations of an illustrative embodiment, the function or functions noted in the blocks may occur out of the order noted in the figures. For example, in some cases, two blocks shown in succession may be executed substantially concurrently, or the blocks may sometimes be performed in the reverse order, depending upon the functionality involved. Also, other blocks may be added in addition to the illustrated blocks in a flowchart or block diagram.

Thus, the illustrative embodiments provide a method and apparatus for exchanging information in a communications environment. In one illustrative embodiment, a wireless communications system comprises a wireless communications unit. The wireless communications unit comprises a communications device, a back-end router, a cryptographic module connected to the back-end router, and a front-end router connected to the cryptographic module and the communications device. The communications device is configured to exchange information over a single wireless communications channel. The front-end router is configured to perform at least one of sending a first data packet received at the front-end router from the communications device to the back-end router through the cryptographic module and sending a second data packet received at the front-end router from the back-end router through the cryptographic module to the communications device.

In the different illustrative examples, the wireless communications system is scalable with any number of wireless communications units. The wireless communications units are configured to be modular in these illustrative examples. Further, these wireless communications units may be connected to each other in the wireless communications system with a lower level of complexity as compared to a communications system in which all of the components are located in a single wireless communications unit.

Further, a wireless communications system in these illustrative examples may be reconfigured while in use or in the field. In this manner, the wireless communications system may be an ad-hoc wireless communications system. For example, one or more wireless communications units may be added, removed, or replaced depending on the desired configuration. Removing one wireless communications unit does not affect the other wireless communications units in a wireless communications system.

The description of the different illustrative embodiments has been presented for purposes of illustration and description, and is not intended to be exhaustive or limited to the embodiments in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art.

For example, although the illustrative embodiments have been described mainly with respect to radio communications systems, the different illustrative embodiments may be applied to other types of communication systems. For example, a wireless communications system may employ wireless communications units that establish different types of wireless communications channels, such as optical communications channels.

Further, different illustrative embodiments may provide different features as compared to other desirable embodiments. The embodiment or embodiments selected are chosen and described in order to best explain the principles of the embodiments, the practical application of the embodiments, and to enable others of ordinary skill in the art to understand the disclosure for various embodiments with various modifications as are suited to the particular use contemplated.

What is claimed is:

1. A wireless communications system comprising:

a first wireless communications unit in a number of wireless communications units in the wireless communications system, wherein the first wireless communications unit comprises:

a communications device configured to exchange information over a single wireless communications channel using a communications protocol;

a back-end router;

a cryptographic module connected to the back-end router; and

a first front-end router connected to the cryptographic module and the communications device, wherein the first front-end router is configured to perform at least one of sending a first data packet received at the first front-end router from the communications device to the back-end router through the cryptographic module and sending a second data packet received at the first front-end router from the back-end router through the cryptographic module to the communications device, wherein the cryptographic module is configured to receive an unencrypted data packet from the back-end router, encrypt the information carried in the unencrypted data packet to form an encrypted data packet, and send the encrypted data packet to the first front-end router as the second data packet, and wherein the first front-end router is also configured to send the encrypted data packet to a second front-end router along a path to a destination for the second data packet, wherein the second front-end router is in a second wireless communications unit in the number of wireless communications units in the wireless communications system; and

a switch connected to the first front-end router in the first wireless communications unit and the second front-end router in the second wireless communications unit, wherein the first front-end router is configured to send the second data packet to the second front-end router through the switch.

2. The wireless communications system of claim **1**, wherein the encrypted data packet is a first encrypted data packet, the unencrypted data packet is a first unencrypted data packet, and wherein the cryptographic module is also configured to receive a third data packet from the first front-end router as a second encrypted data packet, decrypt the information carried in the second encrypted data packet to form a second unencrypted data packet, and send the second unencrypted data packet to the back-end router.

3. The wireless communications system of claim **2**, wherein the back-end router is configured to send the second unencrypted data packet to a next device along a path to a destination for the third data packet.

4. The wireless communications system of claim **3**, wherein the next device is a host connected to the back-end router.

5. The wireless communications system of claim **1**, wherein the first front-end router is configured to send the second data packet to the second front-end router through the communications device over the single wireless communications channel.

6. The wireless communications system of claim **1**, wherein the first front-end router is configured to send the second data packet to the second front-end router using a wired connection between the first front-end router and the second front-end router.

7. The wireless communications system of claim **1**, wherein the first front-end router is connected to a first host authorized to have access to the information belonging to a first security category and wherein the back-end router is connected to a second host authorized to have access to the information belonging to a second security category.

8. The wireless communications system of claim 1, wherein the communications device in the first wireless communications unit is configured to exchange the information over the single wireless communications channel using a radio frequency signal.

9. The wireless communications system of claim 1, wherein the communications device is a first communications device, the single wireless communications channel is a first wireless communications channel, the back-end router is a first back-end router, and the cryptographic module is a first cryptographic module, and

wherein the second wireless communications unit comprises:

a second communications device configured to exchange the information over a second wireless communications channel using another communications protocol;

a second back-end router;

a second cryptographic module connected to the second back-end router; and

the second front-end router connected to the second cryptographic module, the second communications device, and the first front-end router in the first wireless communications unit.

10. A communications network comprising:

a number of sub-networks in which a sub-network in the number of sub-networks comprises a group of radio communications systems in which a radio communications system in the group of radio communications systems comprises a number of radio communications units and in which a first radio communications unit in the number of radio communications units comprises:

a communications device configured to use a communications protocol to exchange information over a single wireless communications channel using a radio frequency signal;

a back-end router;

a cryptographic module connected to the back-end router; and

a first front-end router connected to the cryptographic module and the communications device, wherein the first front-end router is configured to perform at least one of sending a first data packet received at the first front-end router from the communications device to the back-end router through the cryptographic module and sending a second data packet received at the first front-end router from the back-end router through the cryptographic module to the communications device, wherein the cryptographic module is configured to receive an unencrypted data packet from the back-end router, encrypt the information carried in the unencrypted data packet to form an encrypted data packet, and send the encrypted data packet to the first front-end router as the second data packet, and wherein the first front-end router is also configured to send the encrypted data packet to a second front-end router along a path to a destination for the second data packet, wherein the second front-end router is in a second radio communications unit in the number of radio communications units in the radio communications system; and

a switch connected to the first front-end router in the first radio communications unit and the second front-end router in the second radio communications unit, wherein the first front-end router is configured to send the second data packet to the second front-end router through the switch.

11. The communications network of claim 10, wherein the first front-end router is connected to a first host authorized to have access to the information belonging to a first security category and wherein the back-end router is connected to a second host authorized to have access to the information belonging to a second security category.

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